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PATENT INVENTIONS.

No. LXI. NEW SERIES.—JANUARY, 1839.

Specification of a Patent granted to WILLIAM FOTHERGILL COOKE, *of Breed's Place, Hastings, in the County of Sussex, Esquire, and* CHARLES WHEATSTONE, *of Conduit Street, Hanover Square, in the County of Middlesex, Esquire, for Improvements in Giving Signals and Sounding Alarums in distant Places, by means of Electric Currents, transmitted through Metallic Circuits.*—Sealed June 12, 1837.

WITH AN ENGRAVING.

To all to whom these presents shall come, &c. &c., *Now know ye*, that in compliance with the said proviso, I, the said William Fothergill Cooke, for myself and for the said Charles Wheatstone, do hereby declare that our said invention is described and ascertained, in manner following, and by the aid of the three sheets of drawings hereunto annexed (that is to say) :—

I shall first describe certain apparatus or mechanism, which is constructed according to our said improvements for giving signals and sounding alarums in distant places by means of electric currents transmitted through metallic circuits, and then at the conclusion of this our specifi-

cation, I shall point out the particular improvements whereof the exclusive use is granted by the said letters patent.

The description of the apparatus or mechanism will be facilitated by considering it as being composed of the following principal portions, which operate in concert for giving signals or sounding alarums in distant places.

One of those portions is situated at a convenient place (which may be called a terminus), and adapted for being operated upon by a person who intends giving signals or sounding alarums in distant places.

Another portion, with duplicates of it, if required, is situated at the distant places, where other persons are to receive the intended signals or alarums, and is adapted for exhibiting such signals or sounding such alarums; and note, there may be, if required, several duplicates of the last mentioned distant portion, situated one beyond another in different distant places, all which duplicates will operate simultaneously, that is, they will exhibit like signals (or they may sound like alarums) in all the several more and more distant places at the same time, but the place where the most remote of all the said duplicates is situated, may be called the distant terminus.

And for communicating between the several portions of the apparatus which are situated as aforesaid, at a distance one from another, a number of metallic rods or wires, which are suitably arranged and prepared for conducting electric currents throughout their lengths, are extended from the first mentioned terminus and portion of the apparatus aforesaid, to reach through all the other aforesaid more and more distant portions thereof, to that portion which is at the distant terminus.

The arrangement of the said conducting wires being such, that they form as many distinct lines of extension or courses capable of conducting electric currents from one terminus to the other, as there are wires, each wire being kept distinct or insulated from all the other wires;

also that in extending from the first mentioned terminus and portion of the apparatus to the nearest duplicate of the distant portion thereof (if there be any such duplicates), and in thence proceeding onwards to another more distant duplicate, and so on to the most remote of those duplicates which is situated at the distant terminus, each wire must preserve its own continuous course of extension, distinct and insulated from all the other wires, so as to be qualified for transmitting or conducting an electric current throughout its whole length, from the first mentioned terminus and portion of the apparatus to the most distant portion thereof at the other terminus, without interruption to the continuity of the said current in passing through as many duplicates of that most distant portion as may be established at intermediate places between the two termini. But note, it is not an essential part of the apparatus that there should be any such duplicates of the distant portion; for in cases where it is not required to give signals or sound alarums at any intermediate places between the two termini, the first mentioned portion of the apparatus being situated at one terminus as aforesaid, and the other distant portion thereof being situated at the other terminus, the several conducting wires will extend from one terminus and portion to the other terminus and portion, the several wires being in all cases insulated and kept distinct one from another.

And further, the first-mentioned portion of the apparatus, which is situated at one of the termini as aforesaid, should be provided with some such kind of electric apparatus as is usually termed a voltaic battery, and which may be on any construction which is capable of exciting or producing electric currents through metallic circuits. That is to say, if one end of a great length of insulated conducting rod or wire of metal (forming a continuity of metal) is brought into contact with one pole of such a battery, and the other end of the same wire is brought into contact with the other pole of the same battery, so

that such rod or wire forms what is termed a metallic circuit, then a continuous electric current will be transmitted throughout all the length of such wire or metallic circuit, in consequence of a continual transmission of electric action, which, as soon as such a circuit is formed, begins to proceed from one pole of the battery, and along or through all the length of the conducting wire, with a very great velocity of transmission in order to return to the other pole of the same battery, the electric current thereby performing a circuit from the battery and back again thereto; and the said electric current, or transmission of electric action in a circuit, will continue without interruption or cessation, so long as the metallic circuit is maintained, that is, so long as the aforesaid contacts of the two ends of the conducting wire with the two poles of the battery (and so long as the continuity of metal throughout the whole length of that wire) is continued, provided that the battery is kept in working order. But note, by continuity of metal in the conducting wire, it is not meant that the whole length of such wire is necessarily made of one unbroken piece of metal, but merely that the ends of every separate piece of metal whereof the whole length is composed are effectually connected together with suitable contacts for conducting electric currents.

And the person who intends giving signals or sounding alarums at a distance, can do so by application and pressure of his hands or fingers upon suitable buttons or finger-keys belonging to that first-mentioned portion of the apparatus, which is situated at one terminus, the mechanism of those buttons or keys being adapted (according as they may be pressed) for establishing the requisite contacts and connexions between the poles of the voltaic battery and the ends of certain of the said conducting wires, so as to form those particular wires into a metallic circuit for the transmission of an electric current from one pole of the battery, along one or more of the said particular wires, to the distant portion of the apparatus at the

other terminus, and thence back again through some other (or some others) of the said particular wires to return to the other pole of the same voltaic battery, and thereby perform an electric circuit. The manner whereby such an electric current, through a metallic circuit, is caused to give signals or sound alarums in distant places, will be hereinafter explained.

The said electric current, which is so transmitted through those particular wires, which are thus formed into a metallic circuit, passes without interruption to the continuity of the current in making its progress from the battery through all the several duplicates of the distant portion of the apparatus, which may, as before explained, be situated at intermediate places between the two termini, or else the said current repasses without interruption to the continuity of the current in making its return towards the battery through all the said duplicates, but in either case the electric current is caused to produce a like and simultaneous effect upon all the several distant portions of the apparatus; that is to say, whatever effect the electric current produces upon the most remote portion of the apparatus, which is situated at the distant terminus, it will also produce a like and simultaneous effect upon all the several duplicates of that portion which may be situated at intermediate places between the two termini. And the said transmission of such an electric current will continue so long as the pressure is continued on the aforesaid buttons or finger-keys, but no longer, because the metallic circuit is broken and becomes null the instant that the said buttons or keys are released from pressure, and that a cessation thereby takes place in those contacts and connections which had been for the time established, as aforesaid, between the two poles of the voltaic battery and certain of the conducting wires, in order to form those particular wires into a metallic circuit for the transmission of an electric current through them as aforesaid. And note, by applying pressure of the hand or

fingers upon other suitable buttons or finger-keys amongst divers such with which the said first-mentioned portion of the apparatus is provided, contacts and connections may be formed between the aforesaid ends of the particular conducting wires before-mentioned, and the contrary poles of the said voltaic battery to those poles thereof with which the same ends were before connected, wherefore, although the same metallic circuit will be formed amongst the several conducting wires as before, nevertheless the transmission of the electric current will take place in a contrary direction through that metallic circuit; and such reversal of the direction of the transmission of the electric current through the same metallic circuit, is caused to produce corresponding differences in the appearance and signification of the signals which are given, in manner hereinafter described, in distant places, by transmission of an electric current through the same metallic circuit. And note, by pressure upon other suitable buttons or finger-keys amongst a diversity thereof, the ends of other of the conducting wires with which the apparatus is provided may be connected with the poles of the battery, so as to be formed (in like manner as already described) into a metallic circuit, but which will be a different circuit from that already described, because it will be formed by different wires. And so, according to the number of conducting wires with which the apparatus is provided, several different metallic circuits may be formed, and the transmission of an electric current through each of such different metallic circuits as may be so formed (although excited by the same battery), may be caused to give a different signal in distant places, each of which signals is susceptible of two different significations, according as the current is caused to proceed through the particular metallic circuit in one direction or in the contrary direction. And note also, the apparatus or mechanism may be so arranged, as that by pressure upon suitable of the said buttons or finger-keys, two (or in some cases more) of

the said different metallic circuits may be formed out of the several conducting wires at the same time, for the cotemporaneous transmission of two or more distinct electric currents, which may be excited by the same battery; and although each of such currents should only give one signal (with one or other of those two significations which belong thereto, according to the direction in which the current acts), nevertheless, the combination or concurrent exhibition of two or more signals, by means of as many distinct electric currents, may have a different signification to that signification, which would appertain to the exhibition of either of the signals by itself. But note, two concurrent signals may be exhibited at the same time without forming two distinct currents as last-mentioned, but by the transmission of only one electric current through one metallic circuit; because as each circuit is composed of two conducting wires united for the time into one circuit, each wire may be considered as one-half of that circuit, and the electric current, in proceeding along one wire or half of the circuit in a direction from the battery towards the distant terminus, may give one signal, and the same current, in returning along the other wire or half of the circuit in a direction towards the battery (in order to complete its circuit), may give another signal, the simultaneous and concurrent exhibition of which two signals may have a different signification from that which would appertain to the exhibition of either of the signals by itself, or to the concurrent exhibition of either of the said signals, with any other signal with which it might be brought into concurrence. But, notwithstanding that two cotemporaneous signals may be thus exhibited in concurrence by transmission of only one electric current through one metallic circuit, which is composed of two wires, nevertheless, the two signals, which are so brought into concurrence, may be differently paired or their concurrence may be diversified at the pleasure of the operator, because, if each distinct conducting wire, out of a number

of such, is adapted to produce its appropriate signal by transmission of an electric current through that particular wire, then by pressure of suitable buttons or keys, as aforesaid, any two of such wires may be conjoined into one metallic circuit, and the electric current, which is transmitted through that circuit, will exhibit two concurrent signals, which may (at the pleasure of the operator) be the concurrence of any two of the whole number of individual signals, which the several wires are qualified to produce individually.

And by virtue of the several means above-described, the apparatus or mechanism may be arranged, so as to be qualified to form (at the pleasure of the operator) a variety of different metallic circuits, each such circuit being adapted to give its own appropriate signal; but, nevertheless, the electric current, which will be transmitted through each of those circuits, can be made to give two different significations to the signal belonging to that circuit, according to the direction of the current; or the apparatus or mechanism may be so arranged as to be capable of forming two or more metallic circuits with a distinct electric current through each circuit at the same time, in order to exhibit two (or in some cases more) signals in concurrence; or the apparatus or mechanism may be so arranged as to be capable of giving two signals in concurrence by the transmission of an electric current through one metallic circuit, with capability of diversifying the concurrence of the two signals, which will be brought into concurrence by the formation of one metallic circuit; and hence, by one or other or all of those various means, a sufficient diversity of signals and change in the significations of those signals can be given in distant places for constituting a telegraphic language, or mode of communicating letters of the alphabet, and numeral or symbolic characters.

And furthermore, the manner whereby the aforesaid transmission of electric currents through metallic circuits

is caused to give signals, or to sound alarums, in distant places, is either by the angular motions which such currents are capable of giving to magnetic needles, which are poised upon centres of motion, and placed in suitable proximity to the said conducting wires through which such currents are transmitted; or else by the attractive force of occasional magnetism which such currents are capable of exciting in masses of iron which are not magnets themselves, but which are placed in suitable proximity with the said conducting wires through which such currents are transmitted; or else, by the evolution of gas proceeding from water which is decomposed by causing such electrical currents to pass through it; or else, by any two or by all of the said modes of action combined in such manner as is suitable for giving such signals, or sounding such alarums, at a distance, as may be required.

And respecting the adaptation of magnetic-needles for giving signals, the same may be made like compass-needles, but fixed on axes passing through their centres of motion, and those axes mounted delicately on pivots at their ends in the manner of the arbours of watch-wheels, so as to render the needles capable of moving very freely with angular motion about their centres of motion. Each needle must have some slight tendency given to it to induce it to point in one particular direction whenever it is left to itself, uninfluenced by the electrical current; the simplest (and perhaps the best) mode of giving such a tendency, is, by gravitation, in which case the axis of the needle must be horizontal, or nearly so, and one end of the needle being made rather heavier than the other, that heavy end of the needle will always point downwards, when the needle is left to itself. And whenever the needle does so point upwards and downwards, it denotes that it is quiescent, or at rest, and that it is not giving any signal. One of the conducting wires before-mentioned is disposed vertically, or in a direction parallel to

the needle, when the same is at rest, the wire being situated as near to the needle as can be to avoid touching; and when an electric current is transmitted, in manner already explained, through the said wire, so as to pass in proximity to the needle, that current will give the needle a slight tendency to move about its centre with an angular motion or deflection from its previous parallelism to the wire. If the transmission of the current through the wire is in one direction, the needle will acquire a slight tendency to deflect one way from the said parallelism, but if the transmission is in the contrary direction, the tendency will be to deflect the other way. But note, as the tendency to deflection thus given to the needle is but slight, it requires to be multiplied by the same means as is resorted to for a like purpose in the instruments known by the name of Galvanometers; that is, by causing the conducting wire to form many convolutions around the needle, or around a narrow space within which the needle is left at liberty to move, but without touching any of the convolutions that the wire makes; the order of the said convolutions of the wire being such as that the wire shall always transmit the electric current in one direction at one side of the plane in which the needle moves, but shall transmit the current in the contrary direction at the other side of that plane. To produce such convolutions of the wire, it must be coiled around the space in which the needle moves; all the ascending parts of the coils being at one side of the needle, that is, towards one end of its axis, and all the descending parts of the coils being at the other side of the needle (or nearer to the other end of its axis): with this arrangement of the conducting wire, each ascending, as well as descending, part of the several coils will transmit the electric current in the proper direction for giving the needle a tendency to deflection one way or other, according to the direction in which the current is transmitted through the coiled wire; and the concurrence of an adequate number of such coils may be

made to multiply the before-mentioned slight tendency of the needle to deflection, until it becomes sufficient to turn the needle (notwithstanding the gravitation of its heavy end) with a sudden and decided motion to one side or other of its quiescent or vertical position, the instant that the transmission of an electric current through the wire is commenced, by the formation of two of the conducting wires into a metallic circuit by pressure on suitable buttons or finger-keys, as already mentioned.

The extent of deflection, or angular motion, that the needle is permitted to perform, in consequence of the tendency to deflection which it then acquires, is limited by fixed stops; and the instant that, by pressure on the said buttons, a metallic circuit is formed, and an electric current begins to be transmitted through the coils of wire, the needle moves suddenly from its quiescent or vertical position, until it comes to rest in an inclined position against one of its said stops, and it will remain motionless in that inclined position so long as the current is continued; and when the needle is at rest in such an inclined position, it will point to some character, letter, figure, or symbol which is marked on a suitable dial or tablet; and it is by so causing the needle to point to such character, letter, figure, or symbol, that a signal is given. When the needle is thus made to incline to one side of its quiescent or vertical position, as far as its stop will allow, it will point to, and signify, one character, letter, figure, or symbol on the dial or tablet; but when, by reversing the direction of the electric current through the coiled conducting wire, as already mentioned, the needle is made to incline to the other side of its quiescent or vertical position, it will point to, and signify, a different character, letter, figure, or symbol on the same dial or tablet. And the instant that the electric current through the coiled conducting wire is discontinued, by releasing the buttons or finger-keys from pressure, and thereby breaking or nullifying the metallic circuit through which the electric

current was transmitted, then the needle returns, by the gravitation of its heavy end, to its quiescent or vertical position, in which it will not point to, or signify, any character, letter, figure, or symbol, on the dial or tablet. And the needle will remain at rest in that quiescent or vertical position, until the transmission of an electric current is resumed, in manner before stated. And it will, in most cases, be expedient to affix another second magnetic needle upon the same axis as that needle already mentioned, which is included in the space within the coils of the conducting wire, as aforesaid; the said second needle being parallel to the former, but so far along the axis thereof, as to be beyond, or exterior to, those coils of the wire within which the first-described, or principal needle, is situated. The second needle, which may be called the exterior needle, must be reversed, end to end, in respect to the first described, or principal needle, which may be called the interior needle; that is to say, if the north pole of one needle points directly upwards, when they are both in their vertical or quiescent position, the north pole of the other needle must point directly downwards. By this reversal of the poles, the exterior needle will be in proper relative position in respect to those coils of the conducting wire which are nearest to it, so as to be suitably situated for receiving the deflecting influence of those coils, and therefore the exterior needle will be caused to concur with the interior needle, in assuming the required inclining position. Also by their reversed poles the two needles neutralize each other's terrestrial magnetism, or tendency to assume the direction of dipping needles, or of compass needles, the two needles when thus reversed forming what is well-known by the term of an astatic combination. The exterior needle is that which should point to the characters, letters, figures, or symbols, which are marked on the dial or tablet before mentioned, in preference to the interior needle, which is too much concealed within the coils of the wire to be convenient for that pur-

pose. The axis of the two needles may pass through the plane of the said dial or tablet, and have the exterior needle fixed on at the front of that plane, the coils of conducting wire, and the interior needle being behind the same plane. And note, it must be understood in all cases, not only that the several conducting wires, with which the apparatus is provided, are effectually insulated one wire from another wire, as before-mentioned, but also that the different coils which the same wire is caused to make, as aforesaid, around the space in which the interior needle is included, are also effectually insulated one coil from another adjacent coil, in order that the electric current which is to be transmitted through the conducting wire may be really transmitted from one end of each wire to the other end thereof, without being able to find a shorter course or circuit, by lateral transmission, out of one coil or wire into another adjacent coil or wire. The requisite insulation of the wires may be made in the usual manner of preparing the wire used in the instruments called galvanometers, viz., by surrounding or covering the metal of the wire with coils of thread of silk or cotton, or other suitable substance, and such thread covering may be coated with some suitable resinous varnish, which will be impervious to moisture.

An apparatus or mechanism containing a suitable number of magnetic needles of the kind above described, astatic or otherwise, for pointing to, or exhibiting upon, a suitable dial or tablet, all the various characters, letters, figures, or symbols, which are intended to be used in giving signals in distant places, is to be provided at that portion of the apparatus which is situated at the distant terminus herein-before mentioned; and if required, duplicates of the same apparatus or mechanism are to be provided at any intermediate places, between the two termini, where simultaneous and like signals are required to be given. Also, another such duplicate is to be provided at the herein-before first mentioned terminus, in view of the

operator, who intends to give signals in the several more and more distant places, the most remote whereof is the distant terminus, by aid of the other several duplicates of the said apparatus or mechanism. The conducting wires must be arranged so that there is one such wire for each of the astatic or other needles, which is contained, as aforesaid, in every duplicate of the apparatus; that one wire first making its convolutions or series of coils around one of the needles in the duplicate, which is situated at the first terminus in view of the operator, thence extending onwards in continuation from the endmost of those coils to the next nearest duplicate apparatus, and there making like convolutions around the corresponding needle thereof, then extending onwards to the next nearest duplicate, and making like coils around its corresponding needle, and so on to that apparatus which is situated at the distant terminus, where the same wire must also make like convolutions around the corresponding needle of that apparatus. In like manner another such conducting wire, which is insulated from the other wires, is extended in a similar course of coiling round another needle in each of the several duplicates of the apparatus, and so with other wires, in order that every distinct needle in each duplicate may have its distinct insulated wire, but that all the corresponding needles in each duplicate may be connected by the same wire; there may also be an additional wire or wires, extending direct from one terminus to the other, without making any coils or having any connection with any needles. Now if one of the before mentioned wires, which is connected with a set of corresponding needles, is formed, by pressing suitable buttons or finger-keys, into a metallic circuit, by conjunction with a wire which has no connection with any needles, then the electric current, which is transmitted through that circuit, will cause simultaneous and like motion in all the said corresponding needles, but in no others. If such current is transmitted in one direction, all those said corresponding needles

will incline one way, and will all point to, and signify one and the same character, letter, figure, or symbol on their respective dials or tablets. But if the current is transmitted in a contrary direction, the same needles will incline the other way, so as to point to and signify another character, letter, figure, or symbol on their said dials or tablets. That duplicate of the portion of the apparatus which contains needles, and which, as before mentioned, is placed at the terminus in view of the operator, enables him to see what signals he is actually giving when he presses particular buttons or finger-keys, and thereby he may avoid making mistakes. The apparatus containing needles at the distant terminus will exhibit like signals, which may be observed by the person who is to receive them, and so will the several duplicates of the apparatus containing needles, which may be situated at different intermediate places between the two termini; for, as before-mentioned, the needles belonging to every distant portion of the apparatus will exhibit the same signals at the same time. It is obvious, that by releasing the last-mentioned buttons or finger-keys, and pressing others instead thereof, another of the before-mentioned conducting wires, which is connected with another different set of corresponding needles from those last-mentioned, may be formed into a metallic circuit with the same (or with another) wire which has no connection with any needles, and then the same effects, as before-mentioned, will be produced, but upon different needles, and will therefore give different signals. And so on, any other one of those wires, which, as before-mentioned, is connected with a set of corresponding needles, may, whenever it is required, be formed into a metallic circuit, for bringing into operation, and giving signals by, the corresponding needles to which that wire belongs. But so long as only one needle in each duplicate of the apparatus or mechanism containing needles, is rendered operative at the same time, so long will the signals thereby

given be confined within a series of simple significations, or two significations to each needle, according as it is made to incline and point one way or the other way. And in order to bring two or more needles in each duplicate, into concurrent operation at the same time, so as to obtain diversity of significations from their concurrence, two or more distinct metallic circuits may (by pressure upon suitable of the buttons or finger-keys) be formed at the same time out of two or more of those wires which have no connection with needles, together with as many of those wires which belong to sets of corresponding needles; and then the transmission of a distinct electric current through each such circuit, although from the same battery, will actuate two or more needles at once in each of the duplicates of the apparatus containing needles. And it is obvious, that any two of the needles contained in each duplicate may be thus brought into concurrent operation, according as the buttons or finger-keys are pressed; or instead of thus forming two or more distinct metallic circuits for transmission of as many distinct electric currents, another and more convenient mode of obtaining the same result of actuating two needles at once, is, to form a metallic circuit by conjunction of any two of those conducting wires before-mentioned, whereof each one is connected with its own set of corresponding needles; and then the one electric current, which will be transmitted through the metallic circuit so formed, will actuate both such sets of corresponding needles; that is, it will actuate two needles in each of the duplicates of the apparatus containing needles. And by pressure on suitable of the buttons or finger-keys any two of the said last-mentioned conducting wires may be formed into the one metallic circuit, which, as aforesaid, is to bring two needles into concurrent and cotemporaneous operation; wherefore any two out of the whole number of needles in each duplicate of the apparatus containing needles, may be so brought into concurrent and cotemporaneous operation,

and that is done without making use of any of those other wires before-mentioned, which have no connection with any needles, but one of the latter wires must be used for forming part of any metallic circuit, whereby it is required to bring only one of the needles in each duplicate apparatus into operation by the electric current, which is transmitted through that circuit. And in cases where it may be required to bring three of the needles in each duplicate of the apparatus into concurrent and cotemporaneous operation, the same may be done by forming two distinct metallic circuits for two distinct electric currents; one of those circuits being formed by conjoining one of the said wires which has no connection with any needles, to one of the wires belonging to a particular set of needles, the other circuit being at the same time formed by conjunction of two other of the last-mentioned wires belonging to particular sets of needles. But note, three needles in each duplicate apparatus may be brought into concurrent and cotemporaneous operation by one electric current, if the metallic circuit for that current is formed by coupling two of the wires which belong to particular sets of needles with one pole of the battery, and only one such wire with the other pole of the same battery: in which case one-half of the circuit will consist of one wire, but the other half thereof will consist of the said couple of wires; wherefore the transmission of the electric current through the last-mentioned half of its circuit will be divided between the two wires of the said couple, and although so divided, it will actuate both the sets of needles belonging to those two wires, at the same time that the corresponding transmission through the first-mentioned half of the circuit will be confined to one wire, and will only actuate the one set of needles belonging thereto; thus making three sets of needles in all, which are brought into concurrent and cotemporaneous operation by transmission of only one electric current. And note, it is obvious that four sets of needles may (if re-

quired) be brought into concurrent and cotemporaneous operation by transmission of only one electric current, if the metallic circuit for that transmission is formed by coupling two of those wires which belong to particular sets of needles to each pole of the battery; in which case the transmission of the electric current through both the halves of its circuit, will be divided between the two wires of each couple, and although so divided, it will actuate all the sets of needles belonging to all those four wires, which are thus coupled, and whereof the couples are conjoined into one circuit for the transmission of one electric current. And note, in order that the conducting wires may be capable of being conjoined together any one or two of them with any other one or two of them into a metallic circuit, or into metallic circuits, for the formation of a variety of such circuits, as before explained, the said wires must all (or else so many of them as are intended to retain that capability must) be connected together at the most distant terminus by one cross-piece of metal, in a suitable manner for the free transmission of electric currents from that distant end of any one wire to the corresponding end of the other wires. Wherefore when the contrary ends of any one, two, or more of the same wires (which ends are at the first-mentioned terminus) are to be brought by pressure on the buttons or finger-keys into connection with the two poles of the voltaic battery, in any of the various ways of connecting them, (which may be necessary for forming the wires which are so connected into such metallic circuits as are required,) it will in all cases happen that the said two or more wires which are so formed into a circuit, or into circuits, will be already suitably connected by the said cross-piece of metal at the distant terminus for the transmission of electric currents through those circuits. And notwithstanding that the said cross-piece of metal also forms a communication between the distant ends of the wires, then for the time belonging to those circuits, and the distant ends of

other conducting wires, which do not for the time belong to those circuits, nevertheless, as the last-mentioned wires have no connection at their other ends with the poles of the battery, the electric current will not be transmitted (or not in any sensible degree) through those last-mentioned wires, because the current will be confined to the other wires which are actually connected with the poles of the battery, and which, therefore, constitute the intended metallic circuit or circuits.

And furthermore, the apparatus or mechanism hereinbefore set forth, although it has been hitherto described as if it were merely for enabling a person stationed at the first-mentioned terminus to give signals to other persons situated at the distant terminus, and also, if required, at such other intermediate places between the two termini as may be provided with duplicates of that portion of the apparatus which is at the distant terminus, nevertheless, with suitable additions to what has been hereinbefore explained respecting that last-mentioned portion, it is equally capable of enabling a person stationed at the distant terminus to give signals to the person stationed at the first-mentioned terminus, and also, if required, to other persons stationed at all the said intermediate places, so as to communicate intelligence in either direction for carrying on a mutual telegraphic conversation between the persons at the two termini. The said additions are another voltaic battery and set of buttons or finger-keys, with suitable mechanism for them, exactly like those parts already mentioned, as being situated at the first-mentioned terminus. The said additional battery and set of buttons or finger-keys, being applied to that portion of the apparatus which is situated at the distant terminus, will enable the person who is stationed there to connect the distant ends of any of the conducting wires with the poles of the distant battery, so as to form those wires at the will of that person (according as he chooses to press the buttons or finger-keys) into suitable metallic circuits

for the transmission of electric currents, from one pole of the battery at the distant terminus along those conducting wires which constitute one half of the circuit to the other first-mentioned terminus, and from thence back again along those other conducting wires which form the other half of the same circuit to the contrary pole of the same battery; and such transmission is caused to produce all the same signals, and diversity of signals, by means of the different needles as already explained, the transmission being equally operative upon the needles in all the several duplicates of the apparatus which contain needles. The arrangement of the buttons or finger-keys is precisely the same at both termini, and their connections with the voltaic battery are similar, except that the distant battery has its poles reversed in respect to the poles of the other battery; that is to say, the connections which are made between each pole of the distant battery and its several buttons or finger-keys, correspond exactly to those connections which are made between the contrary poles of the other battery and its like buttons or finger-keys: wherefore, if by pressing any particular buttons or finger-keys, they will cause the needles to give a particular signal or signals at every portion of the apparatus containing needles, it follows, from the similarity of arrangement and reversal of the poles of the distant battery, that by pressing the corresponding buttons or finger-keys at the other terminus, they will cause the needles to give a like signal or signals at every such portion. Wherefore all that has been hereinbefore explained respecting the mode of giving signals by a person stationed at the first-mentioned terminus, to other persons stationed at the several more and more distant intermediate places, and at the distant terminus, is also to be understood to be equally applicable to the mode of giving signals by a person stationed at the distant terminus to others stationed at the intermediate places and at the first-mentioned terminus; and note, it is by that duplicate of the portion of the apparatus con-

taining needles, which, as hereinbefore stated, is placed in view of the person stationed at the first-mentioned terminus, that he is enabled to see and receive the signals which the person at the distant terminus intends to give to him. And note, although in general it is intended that the operator stationed at one terminus shall complete the signals, or series of such, which will constitute a distinct idea, or communication from him, before the person at the other terminus begins to return any signals in reply, nevertheless, the apparatus and mechanism will admit, if required, of some signals being made by one party at the same time that other different signals are making by the other party, because some of the conducting wires may be formed into a circuit with the battery at one terminus, whilst others of those wires are formed into a distinct circuit with the battery at the other terminus; and it is obvious, that distinct electric currents may be transmitted through those circuits at the same time, without interference of one with the other; and each of those distinct transmissions will produce its own proper effect upon different needles. And note, there is a cross-piece of metal for connecting the ends of some or all of the conducting wires at the first-mentioned terminus, similar to that cross-piece already mentioned as being at the distant terminus, and for a similar purpose as already explained, viz. it is for keeping the wires connected in readiness for forming any of those metallic circuits which they may be required to form with the distant battery: but when such a cross-bar is provided at both ends of each of the wires, it follows, that whenever any one of those ends is to be connected with its battery, in order to form one-half of a circuit, the said end must be previously disconnected from its said cross-piece. This disconnection is most conveniently effected by the same pressure on the button or finger-key, which causes the intended connection of the said end of the wire with its battery to be effected.

And before proceeding to state the mode of exciting occasional magnetism and of decomposing water, I shall explain the details and drawings of an apparatus and mechanism which is constructed according to the foregoing description.

Figs. A and B, sheet I, are the dial or tablet on which twenty letters are marked in order to be pointed to when required for giving signals, by five magnetic needles, 1, 2, 3, 4, and 5, which are the external needles of as many astatic needles, whereof the details are drawn full size in figs. C, D, E, F, and G. 6, in all those figures is the horizontal axis, whereon the two astatic needles are fixed fast, 1 being the exterior needle, and 7 the interior needle, which latter is included within the numerous coils, 8, that the conducting wire makes around a slight frame, 10, of thin wood, or of metal which must not be iron or contain iron. The use of the frame, 10, is to retain the coils in place, and to preserve a narrow space within the coils for the interior needle, 7, to move in, as shewn in fig. F. The frame, 10, is in two parts, side by side, see figs. D and G, leaving a small interval between them for the axis, 6, to pass through, as is shewn in the horizontal plan, fig. C, and that interval also enables the axis, 6, with the interior needle, 7, to be inserted into its place, in the narrow space within the coils. The two parts of the frame, 10, are united together by their two endmost pieces passing across from one part to the other, and being common to both; also by other cross pieces, 11, which serve likewise to fasten the frame, 10, to the back of the vertical board, A, or fig. A, which forms the dial. The pivots at the two ends of the axis, 6, are sustained in pivot-holes formed in the ends of screws, which are screwed through two horizontal metal bars, 12, 12, one in front of the dial, A, and the other at the back, both bars, 12, being sustained at the ends of horizontal pillars, 13, which project out each way from the vertical board. The dial, A, is very thin at the places where the coils, 10,

apply behind it, in order that the exterior needle, 1, which is in front of the dial, A, may not be far distant from the coils, 8; the conducting wire which is to operate on each needle, or on each pair of needles, 1, 7, which constitute one astatic needle, is first coiled, as at 8, around one half of the frame, 10, and then it crosses over to the other half, and proceeds to coil around the same, the coils being in the same direction in both : the effect of the two halves is nearly the same as one continuous coiling would be. The said coiled wire is copper wire closely covered with silk thread, in the same manner as is used for galvanometers, being about one-thirtieth part of an inch in diameter, which is of a smaller size than we prefer for the other parts of the conducting wires which are extended between distant portions of the apparatus, those wires being copper about one-twelfth of an inch diameter. A great length, and consequently multiplication of coils may be obtained with the small wire without rendering the mass of coils, 8, so large as to remove the exterior coils too far from the interior needle, 7, to exert a due influence thereon. A length of about 200 yards in the coils, 8, 8, around each interior needle, 7, and making about 800 convolutions, is what we have found most suitable. Note, in order more effectually to insulate the coils of wire, one coil from another coil, it is best to line all that part of the frames, 10, with which the coiled wire will come in contact, with woven silk cloth, that is in case those frames are made of metal, and also to interpose a small piece of woven silk cloth between each successive layer of coils, which are laid over a preceding layer of coils, just at the two ends of the frame, 10, where the bending of the wire causes the coils to apply closer to the preceding coils than they do in the straight parts : also in winding on the succeeding coils which are to lay side by side on the frames, 10, they should not be laid so close together as to press very tight laterally one against another. The five needles which are placed side by side in

a row, being all of them astatic, as before explained, do not exert magnetic influence on one another, but each astatic needle when left to itself, that is, when left free from the influence of any electric current through the coiled wire, 8, will settle into a vertical position by preponderance of its heavy end. The stop, before mentioned, by which the angular motion of the interior needle is limited, when by action of an electric current through the coiled wire, 8, the needle is deflected from its vertical position, is fixed at 14 to the side of the frame, 10, across that opening thereof wherein the interior needle, 7, moves. Those stops must be of metal not susceptible of magnetism, and may be wound with silk thread to diminish any tendency of the needle to rebound when it moves suddenly towards and strikes them, that the needle may rest quietly against them. Note, stop-pins fixed into the face of the dial, A, to intercept the ends of the exterior needle, 1, would answer the same purpose as the stops, 14; in either case the stops must be so fixed as to limit the inclination of the needle either way, to conformity with the inclining lines marked on the face of the dial, fig. A, which contains twenty letters disposed at the several intersections of those inclining lines, and the concurrent pointing of two of the five needles always designates some particular letter which is the signal that they give by so pointing in concurrence. For instance on the drawing, needle 1 inclines with its upper end towards the right hand; and needle 4 inclines with its upper end towards the left hand, the mutual convergence of the upper ends of those needles towards each other, shows that the signal they are to give is to be found in the upper half of the dial, and the respective directions in which those two needles point, being continued upwards by aid of the inclined lines marked on the dial, their intersection is the letter B, which is the signal they now give. But if the lower ends of those needles had converged towards each other instead of their upper ends, then the signal they would give would be found in the lower half

of the dial at the intersection of their respective lines of inclination, at the intersection of which is the letter v, and so on of all the other needles. But note, this dial is only adapted for giving signals by the concurrent pointing of two needles, and there are five conducting wires, 21, 22, 23, 24, and 25, each belonging to its respective needle or pair of needles, which constitute five astatic needles, 1, 2, 3, 4, and 5, so that there is no wire of that kind which, as before explained, is not connected with any needles, such wire being unnecessary unless it be required to give signals by inclination of only one needle; and the dial, fig. A, is not adapted to give signals by one needle. The dial, A, and exterior needles are covered in front with a glass, and the coils and interior needles behind the dial are enclosed by boards framed to the vertical board of the dial, in the manner of a close-box, to keep off dust and dampness.

Figs. H, I, and J, represent a set of buttons or finger-keys, whereby the person who intends to give signals in distant places can at pleasure connect the ends of any of the five conducting wires with either of the poles of a voltaic battery, which is assumed to be charged and properly prepared for action. 31, 32, 33, 34, and 35, are five finger-keys of metal, fixed fast by one end of each key to a piece of wood, 19, which is erected on one end of the key-board, 18, the other end of the key may be pressed down, and then the key will bend like a spring, but with a tendency to rise up again when permitted. To these five keys the ends of the five conducting wires, 21, 22, 23, 24 and 25, are connected at the fixed ends of the keys, and the keys being conducting-bars of metal may be considered as prolongations of the several conducting-wires, so that the moveable ends of the keys may be considered to be the ends of the conducting-wires, which have been hereinbefore mentioned as being occasionally connected to the poles of the battery. 17 is the cross-piece of metal before mentioned for connecting those ends of all the several wires, one to

another in readiness for forming part of some metallic circuit. The cross-piece, 17, is fixed upon legs erected on the board, 18, so as to extend horizontally across the ends of all the five keys, which spring upwards by their elasticity, so as to touch beneath the cross-piece, 17, and that forms the stop to the springing up of each key. There are two buttons, as 41, 51, for instance, applied to each key (as 31, for instance,) for the operator to press down either one or other with his fingers, one of which buttons, 41, being pressed will bend down the key 31, and connect that key, (and consequently the conducting wire, 21, whereof it forms the end) with one pole (say the positive pole) of the voltaic battery, in consequence of the lower end of the stem of the button, 41, going down in contact with a fixed cross-bar, 26, called the pole-bar, which is connected with the positive pole of the battery by any suitable connecting wire, 27, and at the same time by the bending down of the key, 31, its extreme end is disconnected from the cross-piece, 17, and thereby the end of the wire, 21, becomes disconnected from its previous connexion with the other four wires. Wherefore by pressure on the button, 41, the key, 31, which may be considered to be the end of the conducting wire, 21, is become connected with the positive pole of the battery, so as to form one half of a metallic circuit; but in order to constitute a complete metallic circuit which will transmit an electric current, some other wire must be connected with the negative pole of the same battery, and to do that another button, 54, for instance, which is one of the buttons belonging to the key, 34, of the conducting wire, 24, being pressed down, will bend down its key, 34, so as to disconnect the end thereof from the cross-piece, 17, and also the end of the button, 54, will go down into contact with another fixed pole-bar, 36, which is connected by a wire, 37, with the negative pole of the battery, and, therefore, by such pressure on the button, 54, the key, 34, which may be considered to be the end of the wire, 24, is

become connected with the negative pole of the same battery. And note, this being done only on that set of buttons or finger-keys, figs. H, I, J, which is situated at one terminus, the other like set of buttons or finger-keys, at the other terminus, which are represented by figs. *h*, *i*, *j*, will stand with its corresponding keys, 31, and, 34, in those figures (which keys may be considered as the distant ends of the said two conducting wires, 21 and 24), in contact with the cross-piece, 17, figs. *h*, *i*, and thereby the said two distant ends of the wires, 21 and 24, are connected together. The instant that the said two buttons, 41 and 54, are thus pressed, an electric current will begin to be transmitted along the two wires, 21 and 24, in the following manner, viz.: from the positive pole of the battery along its connecting-wire, 27, and pole-bar, 26, and button, 41, (which has just been pressed down into contact therewith, as above explained,) and thence along the key, 31, of that button, and along the conducting-wire, 21, of that key, to the coils, 8, (fig. c,) which that wire makes around the interior needle, 7, (fig. c,) belonging to theexterior needle, 1, fig. A, and the said transmission of the electric current, being in the direction from the positive pole of the battery through those coils, causes the needle 1, fig. A, to incline instantly from its previous vertical or quiescent position, to turn its upper end towards the right hand as far as its stop, 14, will allow it to go; and the electric current so transmitted through the coils belonging to the needle, 1, thence proceeds along all the long extension of the conducting wire, 21, to the nearest of the distant portions of the apparatus containing needles, which, supposing for a moment that there are no duplicates at intermediate places, between the two termini, will be that portion or dial and set of needles, which is situated at the distant terminus, and which is represented edgeways by fig. *b*, and is in every respect a duplicate of what has been already described by figs. A, B, to G. At that distant terminus the electric current, which as aforesaid

is transmitted through the conducting wire, 21, and which wire there makes coils around the first needle of the dial, fig. *b*, will, in passing through those coils, incline that first needle with its upper end to the right, the same as before described respecting the other dial, fig. A; and the electric current, so transmitted through the said coils, thence proceeds along the continuation of the conducting-wire, 21, figs. *b* and *h*, to the key, 31, figs. *h* and *i*, and along that key to the cross-piece, 17, with which the key, 31, is in contact, then passing laterally through the piece, 17, the electric current gets to the key, 34, which is also in contact with 17, and begins its return towards the battery along the conducting-wire, 24, and thereby to the coils which that wire makes around the fourth needle of the dial, fig. *b*, at the distant terminus, and the said transmission through those last-mentioned coils being in a direction towards the negative pole of the battery, causes the said fourth needle to incline with its upper end towards the left hand; and the electric current, transmitted through the said coils, thence proceeds along all the long extension of the conducting-wire, 24, to return to the first-mentioned terminus, supposing, as before, that there are no duplicates at intermediate places between the two termini, and at the first-mentioned terminus, the electric current returning along the conducting wire, 24, is transmitted through the coils which that wire makes around the needle 4, fig. A, and that transmission being in a direction towards the negative pole of the battery, as before mentioned, respecting the fourth needle of the distant dial, fig. *b*, causes the needle, 4, to incline with its upper end to the left hand, as is represented in fig. A, and thence from the said last-mentioned coils the electric current returns along the conducting wire, 24, fig. A, to the key, 34 fig. H, and along that key, and through its button, 54, (which has just been pressed down in contact with the pole-bar, 36,) the electric current enters that bar, and thence, by the connecting wire, 37, passes to the negative pole of the

battery, thus completing its long and very intricate circuit above described: but which may be briefly recapitulated to be proceeding from the positive pole, 27, along all the continuous extension of the wire, 21, including all the coils that it makes around needle 1, fig. A, and around the first needle of fig. *b*, to the cross-piece, 17, fig. *h*, at the distant terminus, and passing laterally by that piece, 17, to the other wire, 24, returns along all the continuous extension of that wire, including all the coils that it makes around the fourth needle of fig. *b*, and around needle 4, fig. A, to return to the negative pole, 37, of the battery. The said long and circuitous transmission of the electric current begins instantaneously on pressing down the two buttons, 41 and 54, so as by their respective contracts with the pole-bars, 26 and 36, to conjoin the two wires, 21 and 24, into a metallic circuit, and the needles belonging to those two wires assume their respective inclining positions almost instantaneously; wherefore they present precisely the same appearance at the same time on the dial, fig. A, at one terminus, and on the dial, fig. *b*, at the other terminus, the signal which they indicate being the letter B on both dials. And note, if there were duplicates of the apparatus containing needles, situated at intermediate places between the two termini, the same would be exact duplicates of that which has been already described by figs. A to G, and the conducting-wire, 21, would, in passing through each such duplicate, make coils around the first needle thereof, and the wire, 24, would make coils around the fourth needle of each such duplicate; wherefore the effect of the electric current would be the same on the needles in each of the duplicates as already described respecting the dials at the two termini, and the same signals will be exhibited by the needles of all the several dials, as well at intermediate places as at the two termini. The electric current will continue to be transmitted through the circuit so long as the two buttons continue to be pressed, provided that the battery con-

tinue in vigor, and the two needles which have in consequence been thrown into an inclining position, will continue steadily in their inclining and pointing position: but when the operator who has given them that position, (in the present case, that is, he who is at the first-mentioned terminus, and who has pressed the two buttons, 41 and 54, fig. H,) has kept them pressed down during a sufficient and previously appointed time for the person at the distant terminus to have observed the needles of the dial there, fig. *b*, and to have recorded the signal which two of the needles thereof point to, (that is in the present case, the first and fourth needles pointing to the letter B,) then the person at the first mentioned terminus, releases the two buttons, 41 and 54, fig. H; whereupon their keys, 31 and 34, spring up by their own elasticity, raising the lower ends of the stems of the buttons from contact with the two pole-bars, 26 and 36, and thereby disconnecting the two wires, 21 and 24, from the poles of the battery, and the ends of the keys, 31 and 34, come up in contact with the cross-piece, 17; that contact connects the two wires, 21 and 24, together; and the instant that the buttons are so released, the metallic circuit being thereby broken, the electric current ceases, and then the two needles of each dial, which had been inclined by action of that current into pointing positions, fall back quickly to their quiescent or vertical positions by the gravitation of their heavy ends, and as soon as the person at the distant terminus perceives that the needles have done so, he knows that the intended signal, B, for instance, is completed, and he prepares his mind either to receive another succeeding signal which may be sent to him, or else to return an answer to what he has received, or to make some appointed signal in acknowledgement of the receipt. The best and surest mode of doing which will be to repeat or send back the same signal he has just received as the final signal of a series: for this purpose, the person at the distant terminus has only to press the two corresponding buttons, (in this case buttons

41 and 54, fig. h,) and they will connect the conducting wire, 21, with the negative pole of the battery at the distant terminus, and the wire, 24, with the positive pole thereof, and thereby the first and fourth needles will be caused to point out the letter B on all the dials, fig. A and fig. *b*, just as before described, because a metallic circuit will be formed, and an electric current will be transmitted through those two wires, 21 and 24, in the same direction through each of them, as already described, although excited by the battery at the distant terminus. And all that has been now fully described in respect to two of the wires, 21 and 24, with their keys, 31 and 34, and their buttons, 41 and 54, and their needles, 1 and 4, in each of the several dials and duplicates thereof, is equally true of any other two of the five conducting wires with their corresponding keys, and buttons and needles, and cannot, therefore, require further description. But note, each key is provided with two buttons, as hereinbefore mentioned, whereof one button is for connecting that key and its wire with the positive pole of the battery, and the other button is for connecting the same key and wire with the negative pole of the same battery. The use of two buttons is to be enabled to cause each needle to incline either way from its perpendicular position, and thereby to point to a different letter on its dial. For instance, if the buttons 51 and 44, are pressed down instead of 41 and 54, although they belong to the same two keys, 31 and 34, and wires 21 and 24, and needles, 1 and, 4, as already described; nevertheless the result will be to transmit the electric current through both those wires, 21 and 24, in a contrary direction to that already described, and consequently to incline the needles in a contrary direction; that is, needle 1, will turn its upper end to the left, and needle 4, will turn its upper end to the right, consequently their convergence or concurrence will be downwards, and by examination of the lower half of the dial, fig. A, it will be found that they will point to the letter V, thereon, which will be the signal

given by pressing the two buttons 51 and 44, in like manner as the letter B, was the signal given by pressing the two buttons 41 and 54, as before explained. It only remains to state that the stems of the two buttons to each key are fitted through sockets or holes in the key, and have a certain latitude of motion up and down, through those sockets, independent of the key, but the extent of that motion is limited by two shoulders on each of the stems of the buttons; and slender springs affixed to each key are applied to each button, to bear the same upwards in its socket as far as the lowermost shoulder on the stem will allow the button to rise up from the key. The said springs of the buttons are more yielding than the elastic flexure of the key. The consequence is, that whenever a button is pressed it first moves down in its socket through the key, by the yielding of its own slender spring without moving the key, until the upper shoulder of the stem comes to act upon the key, and then the further continuance of the pressure on the button bends down the key until the lower end of the stem of the button touches on the one or other of the pole-bars, 26 or 36, beneath it, so as to form the intended connexion of the key with one of the poles of the battery; but the other button of the same key which is not pressed being borne upwards as far as it can go up in its socket through the key, by its own slender spring, will not be carried down low enough by the bending of the key to cause its lower end to touch that pole-bar 26 or 36, which is beneath it. By this means there is no risk of both buttons of the same key forming contacts at the same time, unless both were to be pressed upon, which is never to be done. And note, all the contacts which are to form part of the metallic circuit which is to be established, must be rendered secure, that the metals do actually touch. The springs by which the stems of the buttons are urged upwards in their sockets, being fixed to the keys, will ensure a sufficient contact of the buttons and their keys. The elasticity of the keys

will ensure their contacts with the cross-piece, 17, whenever that contact is required; and where the communicating wires are connected to the keys, the thread covering and varnish must be removed, and the bare metal of the wire held in actual contact with the metal of the keys by screws, and the additional precaution of soldering will be proper. And in like manner the junctions of the several pieces, whereof the long extension of each conducting wire is formed, should be united by removing the thread covering and looping, or twisting, or otherwise joining the ends so that the metal of one comes in actual contact with the metal of the other, and such contact may be rendered secure by soldering, and then a covering of thread is to be wound about the joint.

(*To be continued.*)

Specification of the Patent granted to WILLIAM JAMES GIFFORD, *of Gloucester Place, in the County of Middlesex, Surgeon, for Improvements in Paddle-Wheels.* —Sealed September 7, 1837.

WITH AN ENGRAVING.

To all to whom these presents shall come, &c. &c.—*Now know ye*, that in compliance with the said proviso, I, the said William James Gifford, do hereby declare the nature of my said invention, and the manner in which the same is to be performed, are fully described and ascertained, in and by the following statement thereof, reference being had to the drawings hereunto annexed, and to the figures and letters marked thereon, (that is to say):—

Description of the Drawing.

Fig. 1, here represents the side view of an arrangement of paddle-wheel, constructed according to my improvements. *a*, being the main or driving shaft, to which the side framings of the paddle-wheels are attached

detent (which is the weaker spring) is always pressing against the locking detent, except when the verge lifts it in passing the right hand way to their proper situation, and the tail end of the locking detent falls against the stop at K.

The springs, E and G, are fastened to the studs, L, and can have more or less tension given to them, by turning them right or left. This view of the escapement is from the inside of the potter's plate.

What I claim as new, is the two detents upon separate axles, which give me the advantage of using very delicate springs, and of locking the pallet-wheel very near to the centre of a circular detent, and of unlocking it, without passing the verge farther than is requisite in other chronometer escapements, so that the balance is less opposed in raising the locking, and in its return, after receiving the impulse, by which means the same mean power is enabled to carry a much heavier balance.—In witness whereof, &c.

Enrolled December 8, 1838.

Specification of a Patent granted to WILLIAM FOTHERGILL COOKE, *of Breed's Place, Hastings, in the County of Sussex, Esquire, and* CHARLES WHEATSTONE, *of Conduit Street, Hanover Square, in the County of Middlesex, Esquire, for Improvements in Giving Signals and Sounding Alarums in distant Places, by means of Electric Currents transmitted through Metallic Circuits.*—Sealed June 12, 1837.

(*Continued from page* 25.)

The long extensions of the conducting-wires, which may be called telegraphic-wires, may be lodged in channels formed in wood-rails and lined with any suitable resinous matter, with a covering-rail of wood over the channels, to protect the wires from injury and from damp. Such wooden rails may be according to the section,

figure 21, sheet III, formed in as long pieces as can be readily procured; the rail containing the wires may form a square rail, and the covering-rail the upper half of a square-rail, which may be fixed with one of its angles upwards, on the tops of upright posts fixed in the ground, in the manner very commonly used for post-and-rail fences along embankments and other places, on public roads: the rails being lodged in angular notches, on the tops of the posts, are bound down, and secured therein by straps of broad hoop-iron, bended over the upper angle of the rail, and reaching down the sides of the post, and nailed thereto; large posts may be applied at the junctions of the pieces of rails, to receive and sustain the adjacent ends of two pieces, and the joint may be made firm by any suitable application of iron. The joints of the pieces composing the upper half, may be interspaced to those of the lower half, and smaller supporting posts may be applied in the intervals, between any joints. As many parallel-channels as there are conducting-wires, may be cut out with circular-saws, along the middle part of the lower half of such rails, and after those rails are laid in places on their posts, and the channels being lined with suitable resinous varnish, then the wires suitably covered with thread, if necessary, and varnished, may be lodged in the channels, and fillets of wood may be driven in to fill up each channel over the wire; which being thus enclosed, the upper half or covering-rail may be applied, with felt interposed in the joint, and secured by the iron straps over the posts, and such other intermediate bands of iron as will be requisite for fastening the two securely together, like one rail, to keep out wet, and give it sufficient strength to resist injury. The bottom half may, as before mentioned, be a square rail, with a covering-rail, as in figure 21, placed angle-upwards over it, that form being best for a covering, because the rain water will not rest upon it.

Fig. 22, is a section of another form of rail, containing distinct channels for the several wires, each of which

channels is closed by a fillet of wood driven into it. Such rails may be laid under ground, when that is more convenient than to place them above ground upon posts, and some parts of a long line may be under ground, and other parts above ground, and may extend along the sides of public roads, or railways, or otherwise, as is most convenient and suitable, to go from one terminus to the other.

And for telegraphic communications between places which are too distant for an electric current to be transmitted all the way, with sufficient vigour to be certain in its operation; a chain of such apparatuses as hereinbefore described, must be established, to communicate one to another through the whole distance, in which case what has been called the distant terminus of one apparatus, will be situated close by the commencing terminus of the next apparatus, and the signals received there from one apparatus, must be sent forward by the next, and so on: all which requires no explanation, because it is well known in the usual system of telegraphic communication and forms no part of our present invention; and the same may be said of the telegraphic language or system of signals, and their significations; these systems which are well known, and in use for other telegraphs, may be used, or they may be modified, but they form no part of our invention.

And note, instead of enclosing the several conducting wires in distinct channels, as above described, they may all be carried along one channel, for, provided that they are kept dry, their covering of thread and varnish will form a sufficient insulation of each wire from its neighbours. The whole number of conducting wires may be bound together in a bundle by a wrapping of coarse thread and varnish over; that may, if required, be covered again with a spiral fillet of hemp, and then covered with pitch or tar to keep out wet. The one channel receiving a set of wires either when so bound together or when

detached one from another, may be formed in wood rails put together in two halves, or in iron troughs or tubes formed of hoop-iron, bended up and put together in two halves, and united with screw-bolts at suitable intervals, having tarred felt interposed in the joint between the two halves; or tubes may be formed by bending up hoop-iron with a sufficient longitudinal opening left between its meeting edges, to introduce the wires one by one, and afterwards closing up the opening by inserting tarred felt, and pinching the edges together thereon by screw-bolts applied at suitable intervals.

Fig. 23, represents such a tube, and explains how the ends of the several pieces thereof may be united by sockets of the same description, made large enough to receive the ends of the tubes.

Fig. 24, explains how a rail of wood may have an inverted gutter or trough of iron applied upon it, to cover over and protect the wires which are laid upon the wood, without being let into channels therein. The two edges of the inverted iron trough may be let into two channels cut in the wood and cemented in with pitch or tar, and the iron may be fastened to the wood by iron staples applied over it, and driven into or otherwise fastened to the wood. The junctions of the several lengths of iron may be covered over with short lengths of similar gutter iron, but of larger size, to form sockets for receiving the two ends of the lengths which are to be joined.

And note; the set of buttons and finger-keys represented in figs. *h*, *i*, *j*, sheet, 1, are rather differently constructed from what has been hereinbefore described, inasmuch as that the sockets, into which the stems of the buttons are fitted, instead of being formed in the keys themselves, are formed in the two pole-bars, 26 and 36, which bars are fixed across over the keys, instead of under them, as before described, being supported at their ends on upright legs erected on the board, 18. The stems of the buttons are fitted into their said sockets with slender

springs to urge them upwards therein, and there are shoulders on the stems to limit the extent of motion therein, as before described. When pressure is applied on any button the same is forced down in its socket in opposition to its own slender spring, until its lower end gets down in contact with the key, which thereby becomes connected with the pole of the battery, and then the button being pressed still lower, it bends down the key so as to remove the extreme end thereof from its previous contact with the crosspiece, 17.

And note; the apparatus represented in sheet 1, (as the same has been hereinbefore described) must necessarily give all its signals by the concurrent and co-temporaneous operation of two needles, because each of the five conducting wires makes coils around one of the five needlesin each dial; and whereas two wires must of necessity be employed to form any metallic circuit, it follows that whichever two of the five wires may be so employed, they must bring two needles into concurrent and co-temporaneous operation. Wherefore in order to give signals by operation of one needle at a time, another or sixth wire may be added to extend direct from one terminus to the other, without forming coils around any needles, and the two ends of that sixth wire must be connected to a sixth key, which is added to the set of keys at each terminus, that key having its two buttons precisely the same as all the others; then it is obvious that the apparatus will be qualified for operating at pleasure upon one needle at a time, as well as upon two needles at a time, as already described, or upon three needles at a time, or upon four at a time, or five at a time. For each set of buttons and keys will consist, as before, of two rows of buttons, those in one row being adapted, on pressure, to cause the needles belonging to them to incline and point in one direction, the buttons in the other row, on pressure, causing the same needles to incline and point in a contrary direction, all which is as before described, but now

instead of five, there are six such buttons in each row. The additional key with its two buttons may be disposed at the commencement of the series of five already described, that is, by the side of the first key, which is marked 31, in figs. H and *h*, sheet I, and its two buttons are marked 41, 51; the additional key may be marked 30, its two buttons 40 and 50, and the additional or sixth wire 20, and they may be considered as the blanks or zero of the series, and it is obvious that on pressing down either of the blank buttons 40 or 50, no needle will be moved in consequence of so pressing, but by pressing down at the same time any other one of the buttons, the particular needle thereto belonging will be moved by itself alone, and that one way or other according to the row in which the button that is pressed is situated. The dial, fig. A, (as it has been already described) containing twenty letters, none of them can be pointed out by single needles, but a row of numeral figures may be marked in red ink, as there shewn, and it will be apparent that when only one needle is inclined at a time, that it will point to some one of the red figures, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, on the dial, and not to any letters thereon, and if thought more convenient, such numeral characters may be marked in red around the border or margin of that part of the dial which contains the letters. But note, in cases where the use of six conducting wires may be objectionable on account of the expense of very long lines thereof, five wires and five keys with ten buttons, as before described, and as represented by figs. H and *h*, may be retained exactly, but the fifth key, 35, and wire, 25, will be the blank, which has no connexion with any needles, and one of the five needles of each of the dials will be omitted, and only four of them used, with a suitable dial, such as is represented by fig. Z, sheet III, which dial is adapted to give significations to the pointing of any one needle, as well as to the concurrent and co-temporaneous pointing of two needles.

And now respecting the means of applying the attractive

force of occasional magnetism which may be excited in masses of iron by electric currents, as hereinbefore alluded to. Fig. Y, sheet 1, represents a mode of actuating a magnetic needle, 7, which may for the present be supposed to be one of those belonging to the dial, fig. A, and that the parts represented in fig. Y, are placed at the back of the vertical board of the dial, A, in place of the frames, 10, represented in figs. D to G. U, U, fig. Y, are two pieces of soft malleable-iron bended into the form of a fork, or of the letter, U, or what is termed a horse-shoe form, one such horse-shoe being over the needle, 7, and the other under it, but both being in the same plane in which the needle is to move: the four extremities of the two horse-shoes come very near to the fixed stops, 14, 14, by which the inclining motion of the needle, 7, either way, is to be limited, in manner already explained. 21, is the conducting wire by which the needle, 7, is to be actuated, that wire is covered with silk as before explained respecting fig. G, but it is now wound in continuous spiral coils around the four ends or prongs of the two horse-shoes, U, U, that is to say, the wire, 21, having made a number of coils around one prong of the upper horse-shoe, U, with coil over coil, until a considerable mass of coils is accumulated thereon, (at *r*, for instance,) then passes across to the other prong of the upper horse-shoe, and makes another mass of like coils, *s*, after which the continuation of the same wire, 21, descends and makes a like mass of coils, *t*, around one prong of the lower horse-shoe, and then passes across to form a like mass of coils, *v*, around the other prong, and from the last of those coils the wire, 21, continues on its course of extension in the same manner as if it had formed coils, as before explained by fig. G. When an electric current is transmitted through the wire, 21, and all its several coils, *r*, *s*, *t*, *v*, magnetism will (as is well known) be excited in the horse-shoes, so as to convert them, for the time, into two voltaic magnets, and in consequence of their

relative positions in respect to the needle, 7, they will concur in inclining it from its vertical or quiescent position as far as its stops, 14, will allow it to go. If that electric current is transmitted in one direction, it will cause the needle, 7, to incline one way, or if the current is transmitted in the contrary direction, it will cause the needle, 7, to incline the other way. Or if the electric current is discontinued, then the two horse-shoes will cease to be magnetic, and will allow the needle to return to its quiescent or vertical position, by the gravitation of its lower end, which must be heavier than its upper end, as already fully explained respecting the needles having heavy ends. Wherefore the effect produced upon the needle, by the means explained in fig. Y, will be similar, in every respect, to the effect produced thereon by the means hereinbefore described in respect to figs. D to G. And note, the two horse-shoes, U, U, are to be fixed fast to the back of the vertical board, A, by any convenient means, but the four extremities of the prongs of the horse-shoes, U, U, must not be so situated as to be too near to the ends of the needle, 7, when the same is inclined as far either way as its stops, 14, will allow it to go, because the magnetic attraction of the needle itself for the iron ends of the horse-shoes (although that iron has ceased to be magnetic) might, if they came too near together, impede the free return of the needle to its vertical position by the gravitation of its heavy end. And note, the needle, 7, fig. Y, corresponds to the interior needle, 7, figs. E, F, but the exterior needle belonging to fig. Y, which is to be in front of the dial, is to be a mere pointer of brass or copper, and not a magnetic needle. Wherefore the needle actuated in the manner of fig. Y, will not be according to an astatic combination, which it is advisable for the needles, figs. E, F, to be, as already explained.

And respecting the sounding of alarums in distant places, by means of electric currents transmitted through

metallic circuits, the same may be effected by the attractive force of occasional magnetism excited in masses of iron by such currents, and may be applied in a distinct apparatus, which is only adapted for sounding alarums without giving any other signals than such alarums. See sheet II, fig. R.

n, is a well known piece of clock-work having a bell, *q*, which is sounded, when required, by a hammer actuated by the wheelwork, that wheel-work being turned by force of a spring, or a weight with a cord and barrel, which has been previously wound up, but all motion of the wheel-work is stopped by a detent, *p*, mounted on a horizontal axis, *k*, catching into the teeth of any of the wheels, *l*, as will best suit, and when that detent, *p*, is removed out of the way of the teeth of the wheel, *l*, then the alarum begins sounding its bell; all which is so well known as to require no further explanation, particularly as there are, or may be, various constructions of such alarums, and our improvements therein only relate to the mode of disengaging and re-engaging such detent, *p*, by means of electric currents. Let K, represent a voltaic battery, on any of the constructions commonly used, one of the most simple consisting of a flat vessel of copper, filled with acidulated water, and having a plate of zinc suspended therein, will be sufficient. 21, is a conducting-wire, extending from one pole, which is, in this case, the positive pole, 27, of the battery, to coil around the two prongs of a soft iron horse-shoe, U, first around one prong thereof, and then around the other prong thereof, in the manner shewn in perspective, in fig. S, sheet, II, and as has been already explained respecting fig. Y, sheet I; but now there is only one horse-shoe, instead of two, and no magnetic needle; and after making such coils, the continuation of the conducting-wire, 21, figure R, is extended to such place as is most convenient and accessible to the person who intends to sound the alarum, and there the said wire, 21, is connected to a finger-key, 31, which is

fixed fast by one of its ends, and the other end is capable of being bended down, by pressure, to bring it down into contact with a pole-bar, 26, which is fixed beneath it, and from which another conducting-wire, 22, proceeds, to the other (which is, in this case, the negative,) pole, 37, of the battery, K. When the key, 31, is not pressed, it springs up by its own elasticity, so as not to touch its pole-bar, 26, and no metallic circuit is formed, and so long as that is the case, the detent, *p*, of the alarum, is kept by action of its own spring, *m*, in the way of the teeth of the wheel, *l*, so as to prevent the alarum from sounding, but there is a mass of soft malleable iron, V, fixed across the lower or tail end of the detent, *p*, and extending horizontally across, parallel to the axis, *k*, of the detent, the two ends of the piece of iron, V, being opposite to, and at a small distance from, the ends of the two prongs of the horse-shoe, U, as is shewn in perspective, at fig. 8, sheet, 11; but neither the piece, V, nor the horse-shoe, U, being magnetic, they do not attract each other. The person who intends sounding the alarum, can do so by merely pressing down the key, 31, which he may either do by applying his hand, or finger, to the key, 31, or by pulling down a cord, or bell-pull, *x*, which may be appended to it: in either case, by bending down the key, 31, to touch its pole-bar, 26, the required circuit is formed, and an electric current being transmitted through the conducting-wire, 21, which is coiled round the prongs of the horse-shoe, U, it excites magnetism therein, or converts it for the time into a voltaic horse-shoe magnet, which attracts the piece of iron, V, at the lower end of the detent, *p*, and draws it towards the ends of the horse-shoe, U, although it is not allowed quite to touch them; the upper end of the detent is thereby withdrawn from out of the way of the wheel, *l*, and then the alarum commences sounding or hammering its bell by its own action, derived from its previously wound up weight, or spring, and if the key, 31, is kept down, so long the alarum will continue to sound, until its said weight or

spring is run down; but if the key, 31, is released, so that it can spring up, and separate from its pole-bar, 26, then the circuit being broken, no electric current will be transmitted through the coils of the wire, 21, and the temporary magnetism of the horse-shoe, U, will cease altogether, and it will no longer attract the piece of iron, V, but the spring, *m*, of the detent, *p*, will withdraw the piece, V, from the horse-shoe, U, and will bring the upper end of the detent, *p*, into the way of the teeth of the wheel, *l*, so as to stop the motion thereof, and, consequently, the sounding of the alarum; and note, in order that no adhesion may take place between the ends of the piece of iron, V, and the iron ends of the horse-shoe, U, it should not, as before-mentioned, be allowed to actually touch those ends; which may be managed, by suitable stops, to limit the motion of the detent, *p*, about its axis, *k*, or else two small copper studs may be fixed into the ends of the horse-shoe, or into the ends of the piece, V, to form prominences of copper, which may be allowed to come in contact, and they will prevent the contact of the iron with the iron.

32, 26, fig. R, shews a duplicate-key and pole-bar, which may be provided in another different place from those already described at 31, and 26: the key, 32, having a branch from the conducting-wire, 21, and its pole-bar, 26, having a like branch to the conducting-wire, 22, they will give the means of sounding the same alarum from that different place, as well as from the place first mentioned, and so on, as many other keys and pole-bars as may be required, may be provided at different places for sounding the same alarum. The said apparatus, fig. R, may be applied in dwelling-houses, inns, theatres, or other large buildings, for the same purposes as the ordinary system of bell-hanging, and where the situation does not require too great a length of conducting-wires, 21, 22, in the metallic circuit, so that the electric current will be able to excite a sufficient vigour of magnetic attraction in the horse-shoe, U, the upper end of the detent, *p*, may

have a hammer-head fixed upon it, in order to strike against, and sound the bell, *q*, in the manner represented in perspective, fig. s, by a direct action of the force of the occasional magnetism, which is excited in the horse-shoe, U. But in other situations, the length of the conducting-wires, 21, 22, in the metallic circuit, may be so great, that the magnetism excited in the horse-shoe, U, will not exert a sufficient force of attraction for the piece of iron, V, to remove the detent, *p*, from the teeth of the wheel, *l*. In such situations, the apparatus, fig. s, is to be preferred, wherein the voltaic battery, K, and the iron horse-shoe, U, together with the piece of iron, V, at the lower end of the detent, *p*, are all the same as already described respecting fig. R, and the hammer for sounding the bell, *q*, of the alarum, may be either at the upper end of the detent, *p*, as represented in fig. s, or else the hammer may be moved by clock-work, as already mentioned, and as is represented in fig. R, the office of the upper end of the detent, *p*, being in that case to catch the teeth of the wheel, *l*, in order to prevent the sounding of the alarum, until the detent is removed, as already explained; but, instead of forming a long metallic circuit, to extend all the way from that battery, K, to the distant place or places where the person who attends to sound the alarum, may be situated, and thence back again to the battery, K, as is the case in fig. R, the battery, K, in fig. s, is devoted solely to the purpose of exciting occasional voltaic magnetism in the horse-shoe, U, by transmission of an electric current through no greater length of metallic circuit than is most suitable for that purpose, that is to say, a considerable part of the length is accumulated in the coils around the prongs of the horse-shoe, U. The electric current, which is to be transmitted through the long circuit, which extends to the said distant places, is derived from a distinct battery, M, fig. s, and that current does not operate directly upon the alarum, but it causes the other battery, K, (which may for distinction be

called the alarum battery) to be brought into action, in order that it may sound the alarum in manner already explained. It may be, therefore, considered that the battery, M, and the electric current, which is transmitted from it through the long metallic circuit, formed by the two conducting-wires, 24, 25, is caused to produce the same effect on the alarum apparatus, as has been already described to be done by pressing down the key, 31, fig. R, in contact with its pole-bar, 26; viz., it establishes the requisite contact between the ends of the wires, 21 and 22, fig. S, to form them into a metallic circuit, for the transmission of an electric current from the positive pole, 27, of the battery, K, along the wire 21, and through the coils which that wire makes around the two prongs of the horse-shoe, U, and back again along wire, 22, to the negative pole, 37, of the same battery, K. This connexion is effected by causing the two ends of a small fork, 60, fig. S, to descend into two small cups, 61, 62, formed at the upper end of two upright pillars, 21, 22, which may be considered as prolongations of the wires, 21, 22. A small quantity of mercury is contained in each of the cups, 61, 62; and when the fork, 60, is brought down to dip therein, as is represented by dotted lines, it forms the two wires, 21 and 22, into a metallic circuit, and that will cause the alarum to begin sounding the same as would follow from pressing the key, 31, fig. R; but when the fork, 60, is raised up as represented in fig. S, that circuit is broken, and the alarum ceases to sound in the same manner as would follow from releasing the key, 31. This being understood, it is easy to explain how the small fork, 60, is brought down or raised up by the motion which is given to a magnetic needle, by transmission of an electric current from the distant battery, M, through a long metallic circuit, which may be formed, when required, by the long wires, 24 and 25. The fork, 60, is formed out of one end of a slender lever, 63, 64, which is fixed on the horizontal axis, 65, of

a magnetic needle, which is placed within a set of coils, 8, which the wire, 8, makes around a frame, 10, in the same manner as already described respecting figs. D, G. sheet 1.; the only differences from the structure there represented being, that the axis, 65, of the needle, instead of being mounted on pivots at its ends, is suspended by the tension of horsehairs, which are extended horizontally in prolongation of the axis, 65, from each end thereof to small regulating screws, 66, 66, supported at the upper ends of two small standards, 67, 67, which are erected on the same wooden base as the upright pillars, 21, 22, for the cups, 61, 62; and the frame, 10, for the coils, 8, of wire, is also erected on that same base. Also that frame, 10, instead of being made in two parts, as is represented by fig. D, and as before explained, is here represented in one part, with a small tube projecting out horizontally to admit the axis, 65, of the needle, and keep the coils of wire, 8, apart out of the way of the axis, 65. The lever, 63, 64, which carries the fork, 60, is fixed on the axis, 65, at right angles thereto, and also at right angles to the magnetic needle, which latter is concealed, in fig. s, within the frame, 10. The end, 64, of the lever, 63, 64, has a small weight, which overbalances the weight of the fork, 60, so as to raise the same up out of the cups, 61, 62, as high as the stop, 14, will permit, whenever there is no electric current transmitted through the coils, 8, 8; but the two ends of the wire, 8, composing those coils are connected at 75, 76, with the ends of the two long conducting wires, 24 and 25, as is clearly shewn in fig. s. The wire, 24, is connected with the positive pole, 87, of the battery, M; and from the negative pole, 97, of the same battery, a connecting wire, 36, extends to the finger-key, 31; and to the pole-bar, 26; beneath that key the wire, 25, is connected. Wherefore, if the key, 31, is pressed down into contact with its pole-bar, 26, the two long conducting wires, 24 and 25, will become united into a metallic circuit for the transmission of an electric current

through the following course, viz. from the positive pole, 87, of the battery, M, along the long conducting wire, 24, to the button, 75, and thence through the wire, 8, which is coiled around the frame, 10, in the space whereof the magnetic needle is situated, and continuing from those coils to the button, 76, there enters the other long conducting wire, 25, and along that to the pole-bar, 26, and through that and its key, 31, and connecting wire, 36, to the negative pole, 97, of the battery, M. And the said transmission through the coils, 8, causes the magnetic needle to incline from its perpendicular in the proper direction, and so much as is requisite to put the fork, 60, down into the cups, 61, 62, which, as already stated, will cause the alarum to begin sounding by the action already fully described in respect to fig. R; but when the key, 31, fig. S, is released, then the said metallic circuit is broken, whereupon the electric current ceasing to be transmitted through the coils, 8, ceases to influence the magnetic needle, and therefore, by the preponderance of the weight, 64, the fork, 60, is raised up out of the cups, 61, 62, as high as the stops, 14, will allow, and then the sounding of the alarum ceases, for the reason already explained in respect to fig. R. And note, it is obvious, that the weight or spring which actuates the clock-work of the alarum might, as that weight descends, or that spring unwinds, be made to pull a string which is tied around the wrist of a person who is asleep, or who is dull of hearing, and thereby give an additional chance of his attention being called by the sounding of the alarum beyond that of merely hearing the sound.

And the apparatus above-described and represented in sheet II, may also be applied in concert with the apparatus hereinbefore described and represented in sheet I, to form part of our complete apparatus for giving signals and sounding alarums in distant places, and will form a very important part thereof, because the person who intends giving signals in distant places can first call the attention

of his correspondent or correspondents at the distant places, by sounding the alarum or alarums previously to commencing giving visible signals. For this purpose an apparatus, with an alarum like fig. s, but constructed and adapted to be actuated with clock-work, as in fig. R, is to be provided at each terminus, or place where there is a set of buttons and finger-keys, figs. H, I, J, or figs, *h*, *i*, *j*, sheet I, and also at each intermediate place where duplicates of the dials with needles may be situated; but the long conducting wires, 24 and 25, fig. s, together with the battery, M, and finger-key, 31, and pole-bar, 26, are not required, because the functions of those parts are to be performed by two of the five long conducting or telegraphic wires, viz. 21 and 25, sheet I, together with their sets of buttons and finger-keys. For it is evident that the sounding of the alarums may be performed by transmission of the same electric current which produces some particular signal; for instance, that convergence of the upper ends of needles, 1 and 5, which signifies the letter, A, on the dial, fig. A, and which is occasioned by the transmission of an electric current through the wires, 21 and 25, and their keys, 31 and 35. But as it would be inconvenient to suffer the alarums to be sounded every time when the signal letter, A, is to be exhibited, the alarum should be only kept connected with those two wires in the intervals between the making of telegraphic communications, when the apparatus is not in use, and on proceeding to resume the use of it for giving signals, the prelude, or first thing, will be for the person at the first-mentioned terminus to make the signal for letter, A, by pressing down buttons, 41 and 55, which, producing all the same results as pressing down the key, 31, fig. s, in manner already fully described, will begin sounding the alarum at the distant terminus, and also those at the intermediate places; those buttons, 41 and 55, being held down only a very short time, and then released, and the sounding may be repeated, if necessary, until the atten-

tion of the person at the distant terminus is called to it, and as soon as he is ready to receive signals, he will communicate that fact by sounding the alarum at the first-mentioned terminus, which he does by pressing the buttons, 41 and 55, fig. *h*. And by those means a mutual understanding will have been established between the two persons, that they are both prepared to commence a telegraphic communication, he who commenced by first sounding an alarum, having the right of precedence therein; and then the alarums being unnecessary for the present, each person may disconnect his own alarum from the telegraph wires, but that is merelyto avoid the annoyance of its being sounded every time that signal letter, A, is made by either person, in the course of their communication; but when the person who has, as before stated, acquired the right of precedence therein, intends to put an end to it for the present, he expresses that intention by some unusual signal, which has been previously agreed upon, such for instance as pressing down at once, two of the buttons, 41, 42, in one row, and two of the buttons, 54, 55, in the other row, which will turn the upper ends of the needles, 1 and 2, to the right, and the needles, 4 and 5, to the left, and immediately after the making of such signal, it is to be imperative on each person, to connect his alarum with the telegraphic wires, and to wind up its clock-work weight, or spring, if necessary, in order that the alarums may never fail of being ready for sounding, during all cessations, however short, in the telegraphic conversation; and in order that every resumption of the conversation may be preluded by sounding an alarum; and as to the several alarums at intermediate places between the two termini, they will all begin to be sounded at the same time with that alarum, at either of the two termini, which is first sounded, and the persons who are stationed at those intermediate places, on hearing the sound, and looking at their own respective dials, will discover from which terminus the intended communication will afterwards be

sent, because the signals which follow after the sounding of the alarum, must be adapted to convey that information. The above particulars of the application of the alarums being understood, it is easy to explain the manner of connecting or disconnecting them with the telegraphic wires. The alarum, at the first-mentioned terminus, is to be connected by a short cross wire, 94, extending from the key, 35, of the telegraphic-wire, 25, fig. H, to the button, 75, fig. S, (instead of the wire marked 24, in that figure); and the telegraphic-wire, 25, fig. H, is to be disconnected from its key, 35, by sliding a small bolt, 73, and is to be connected, by means of that bolt, and a short cross wire, 95, to the button, 76, fig. S, (instead of the wire, marked 25, in that figure). To effect the said disconnection of the telegraphic-wire, 25, from its key, 35, it is not joined directly thereto, but to a spring-piece, 72, fig. H, which, by bearing down on the end of the key, 35, connects the wire, 25, therewith, whenever the alarum is to be kept out of use; but when the alarum is to be connected, then the small sliding bolt, 73, being pushed, with its end beneath the spring-piece, 72, will lift the same up from its previous contact with the key, 35, but in so doing, the bolt, 73, makes contact with the spring-piece, 72, which is connected with the telegraphic wire, 25; and the short cross wire, 95, being extended from the bolt, 73, to the button, 76, the bolt, 73, establishes the required connection between that button and the wire, 25. The consequence is that when the bolt, 73, is pushed under the spring-piece, 72, the electric current transmitted along the wire, 25, in producing signal letter, A, must pass through the coils of wire, 8, fig. S, and in so doing will cause the alarum to be sounded, as already fully explained in respect to fig. S; but when the bolt, 73, is withdrawn, the said electric current will not pass through the said coils, 8, fig. S, and consequently the alarum will not be sounded, although the letter, A, is exhibited. In like manner, to prepare the

alarum at the distant terminus for action it requires to be connected with the telegraphic wire, 25, fig. *h*, so that the electric current which is transmitted along that wire, 25, when letter, A, is exhibited, will also be transmitted through the coils, 8, fig. s. The mode of connecting the alarum to the set of keys, fig. *h*, may be an exact duplicate of that which has been explained in fig. H. Another way of preventing the alarums from sounding uselessly during the telegraphic conversation, is, to apply some stop to the motion of their clockwork in like manner as in a stop-watch, which will preclude the necessity of disconnecting the wires, which may be always left in action: this is particularly applicable to the alarums at intermediate places.

And respecting the application of the evolution of gas proceeding from the decomposition of water by the transmission of electric currents, see fig. Q, sheet II.

A, B, is a glass vessel somewhat like an inverted syphon, but with one leg, A, much larger than the other leg, B, which latter is only a narrow tube. The lower part of the syphon is filled with mercury so high up as to occupy all the communication between the two legs, and above the mercury acidulated water is poured into the large leg, A, so as to occupy some depth therein: the upper part of the large leg, A, is closed by a cover, C, and two platina wires, 75, 76, are passed horizontally through perforations through the thickness of the glass, to pass into the midst of that water with their ends turned upwards therein. The two wires, 75, 76, fig. Q, correspond to the wires marked with those numbers in fig. s, and the two points of those wires which are immersed in the water, answer the purpose of the coils, 8, 8, around the magnetic needle in fig. s; for when an electric current is transmitted through the wire, 75, to the wire, 76, the points whereof do not touch each other, the electric current must pass through the water, and in so doing will decompose the same into its elements of oxygen and hydrogen in the state of gases

which ascend in bubbles through the water, and by accumulating in the space above that water beneath the close cover, c, will press downwards on the surface of the water, and thereby press on the mercury so as to raise the same in the small leg, B, until the mercury comes up high enough to touch and surround the end of another platina wire, 61, which turns over and descends down into the small leg, B, but only so far down therein as not to touch the mercury when the same stands at its natural level, but nevertheless so far as that the said end of the wire, 61, will become immersed in the mercury when the same is raised in the small leg, B, by the aforesaid accumulation of the gases, proceeding from the decomposition of the water contained above the mercury in the large leg, A. The said wire, 61, answers to the cup, 61, fig. s, and there is another platina wire, 62, the extreme end of which is inserted through a perforation in the lower part of the glass, so that its end is always immersed in the mercury contained in that lower part. This apparatus, fig. Q, is to be used as a substitute for the magnetic needle and coils of wire around it in fig. s, for the purposes of enabling an electric current, which is transmitted through a very long metallic circuit, and which, consequently, acts but feebly, to continue to accumulate its action until it has attained sufficient force to form the requisite contacts for bringing an alarum battery into action, for the purpose already described in respect to fig. s. Therefore the apparatus fig. Q, being substituted for the magnetic needle and its surrounding coils of wire in fig. s, the connections which are therein made to the buttons, 75 and 76, must, in fig. Q, be made to the ends of the wires, 75 and 76, therein, and likewise the connections which are made to the two cups, 61 and 62, fig. s, are to be made in fig. Q, to the ends of the two wires, 61 and 62, therein; which being done, the apparatus, fig. Q, will by its operation, above described, form the requisite metallic contacts between the end of the wire,

62, and the end of the wire, 61, by the mercury in which they both become immersed to form them into a metallic circuit, and thereby produce all the same effects, as already explained respecting fig. s, for bringing the alarum battery, K, fig. s, into action, when it is required to sound the alarum. And note, after the apparatus, fig. Q, has performed its intended office of forming the ends of the wires, 61 and 62, into a metallic circuit, and has caused the alarum to be sounded, it will not immediately separate that contact of itself, because the gas will continue for some time accumulated in the upper part of the large leg, A. Therefore after the alarum has been sounded, the person whose attention has been called to it, may apply his finger to open a small valve, *d*, in the cover of the large tube, A, in order to let out the gas therefrom, and then the mercury, subsiding to its level in both legs, will sink below the end of the wire, 61, leaving the same disconnected from its contact with the mercury, so as to break the metallic circuit which had been formed thereby.

And note, as the long conducting or telegraphic wires used in our said apparatus may be liable to be broken or otherwise deranged, it is necessary to have some efficient and easy method by which the precise place of injury or derangement may be ascertained, without disturbing to any great extent the tubes, troughs, or rails, wherein those telegraphic-wires may be lodged. The particular wires, in which the injury or derangement may have occurred, will discover themselves, from the defective working of the corresponding telegraphic-needles, at the two termini. At given intervals along the line, each of the conducting-wires should have a short lateral branch-wire proceeding from it, and reaching out therefrom, to some secure place, where the ends of all those branch wires will be accessible, when required for making proof of the wires. These branch wires are provided for the purpose of connecting any two

of the long conducting-wires, with an instrument which may be called a detector or prover. Two convenient forms of such an instrument are represented in sheet III. Fig. w, is a prover, which consists of a multiplier, with its magnetic-needles included in its coils of wire, exactly like those hereinbefore described, figs. D to G, sheet I, but mounted on a stand, with a protecting-case of wood, having a glazed front; and each of the two ends, 8, 8, fig. w, of the coiled wire, proceeding from the instrument, terminates with any convenient clamp of metal, for the purpose of taking hold, with those two clamps, of the ends of any two of the branch-wires before-mentioned, with a good contact, and then the instrument will form part of a metallic circuit, with those two of the conducting-wires, to the branches whereof it is connected. The other kind of provers, fig. L, is a glass vessel or bottle, fixed on a wooden stand, and containing two pieces of platina-wire, *p*, *p*, insulated from each other, with their lower ends soldered respectively to pieces of copper wire, *c*, *c*, each terminating with a clamp, such as above described. The bottle is to be nearly filled with diluted sulphuric acid, or other good conducting-fluid, when required for use. In applying either of these instruments to prove the defective state of the telegraphic-wires, I will speak, for example, of only two wires, and the mode of proving those two, will apply to any others. See fig. w, sheet III: 21, 22, are two of those wires, which extend from one terminus to the other, and I will suppose one of them to have been broken at H; to find out the place, H, where it is so broken, those ends of the two wires, 21, 22, which are at one terminus, should be connected with the opposite poles of the battery, at that terminus. The person who is to examine the state of that conducting-wire which is known to be broken, must proceed to that place nearest to the terminus, where there are a set of lateral branch wires, *k*, *k*, proceeding from the conducting-wires, as before-mentioned, and there he must apply one or other

of the provers above described, with the two wires, 8, 8, thereof, attached to the ends of the branch wires, *k*, *k*, belonging to the two conducting-wires, 21, 22, which have been, as before-mentioned, connected with the poles of the battery. If the defect does not exist between the terminus, and this first proving-place, the prover will act at that place; that is to say, if the prover, w, is used, its needle will be inclined, or if the prover, L, is used, gases will be evolved at the platina-wires, from the decomposition of water. The prover is then to be carried forwards to the next proving-place, where lateral branch wires are provided, farther off from the terminus, and so on successively, by applying the prover at each proving-place, more and more remote from the terminus, a place will be found where the prover ceases to act, and that cessation of its action will indicate that the defect exists between the two last places, which were tried. The portion of the tube, trough, or rail, included between these two last-mentioned places, is then to be opened, near the midway of the distance between those two places, and at that midway, the wires, 21 and 22, must be proved by connecting the wires, 8, 8, of the prover, immediately to each of them. In this manner, the half in which the defect exists, may be detected. Then that half may be again subdivided, and the process continued in the same manner, by repeated bisection, until the place of the defect is ascertained within very narrow limits, and there the tubes must be opened, to expose the wires, and repair the defect; and note, in order to be able at all times to identify the several conducting wires, it will be expedient to use varnish of different colours, in preparing them, wherefore one colour will always distinguish the wire, 21, another colour the wire, 22, and so on of the others.

Having now described our said improvements, I, the said William Fothergill Cooke, for myself, and for the said Charles Wheatstone, do hereby declare that the new invention, whereof the exclusive use is granted to us by

the said letters patent, consists in the following particulars :

Firstly, in the improvement, hereinbefore described, for the purpose of communicating determinate angular motions, to magnetic needles, by means of electric currents, transmitted through metallic circuits, and the adaptation of such angular motions, for the purpose of giving signals in distant places. And whereas, some experiments have been heretofore made by others, upon giving signals, by means of the well known instruments, called galvanometers, which are for measuring the force of electric-currents, passing through metallic circuits ; I wish to be understood that we make no claim to the application of the multiplying coils of conducting-wires, hereinbefore described, around the magnetic needles, but the improvement we have made in the adaptation of magnetic-needles, to the purpose of giving signals, is in disposing the needles in vertical planes (the axes whereon they are fixed, being horizontal), and in making the needles heavier at one end than the other, in order to give them a decided preponderance, or tendency to hang perpendicular and point upwards when they are not influenced by electric currents ; and in limiting the angular motions of the needles, when they are so influenced, to some certain determinate extent by providing fixed stops against which the needles may recline, and continue at rest for a time, in suitable inclining directions, for pointing out, on a vertical dial, the significations of the signals they are to give ; and in case two or more such loaded needles are to be placed near together, in the same vertical plane, for pointing out signals on the same dial, then in the adaptation of astatic needles, that is, two reversed needles, fixed on the same horizontal axis, for giving signals in such cases. But note, the astatic mode of combining magnetic needles for galvanometers being well known, we make no claim to the use of astatic-needles for giving signals, unless such astatic-needles are, as before-mentioned, dis-

posed two or more in a vertical plane, and are loaded at one end, and have their angular motion limited to a determinate extent, by stops.

Secondly, in the improvement hereinbefore described, of combining several magnetic-needles, so that they will point out on one dial, suitably marked, the significations of the signals which they are to give by the determinate angular motions, which are communicated to them by electric currents: those signals being given, in some cases, by the inclination and pointing of one needle; in other cases, by the concurrence and mutual pointing of any two needles; or in some cases, by the concurrence of three or four needles, as may be most suitable for the sort of signals which are intended to be given.

Thirdly, in the improvement, hereinbefore described, of arranging and combining any suitable number of conducting or telegraphic-wires, into a set capable of being operated upon by buttons, or finger-keys, at each end of the set, and having a voltaic battery, and also a dial, with magnetic-needles, as aforesaid, at each end of the set; with power of using those parts, in such manner, that at the pleasure of the operator, any two or more such wires may have one or other of their ends connected to the two opposite poles of the battery, belonging to that end, the contrary ends to those ends which are so connected, being at the same time conjoined together, so as to form the said two or more wires, into a metallic circuit or circuits, for the transmission of an electric current or currents throughout the length of two conjoined wires; as a means of giving signals by the angular motions that such current or currents will communicate to magnetic-needles, which are subjected to the influence of such currents, or of sounding alarums by the conjoined action of magnetic-needles aforesaid, or of the evolution of gas from decomposition of water, by such currents, and of occasional or temporary magnetism, excited in masses of soft iron, by such currents. And whereas, either end of any wire or

wires of such set aforesaid, is capable of being connected with either pole of its appropriate battery, a diversity of metallic circuits can be formed, with a capability of transmitting an electric current in either direction, through each such circuit, and of thereby giving a diversity of signals from a few wires.

Fourthly, in the improvement, hereinbefore described, in the arrangement and combination of each set of the buttons and finger-keys, whereby the ends of all the several conducting-wires, constituting the set thereof, are kept conjoined one to another, in readiness for becoming parts of any such circuits, as may be formed by connecting the opposite or distant ends of the wires with the distant battery; but, nevertheless, the several buttons and keys, hold all the several ends which belong to them, in due order for enabling the operator to disjoin any two or more ends, from their fellow-ends, by an instantaneous touch, which likewise connects the ends so disjoined with either pole of the battery, belonging to the keys; and vice versâ, the same self-action of the keys, whereby they disconnect the said ends from those poles, when the buttons are released, likewise rejoins those ends to their fellow-ends in the set.

Fifthly, in the improvement, hereinbefore described, whereby a set of combined conducting-wires, as afore said, having a voltaic battery, and a set of buttons or finger-keys, and also a dial, with magnetic needles, for giving signals, as well as an apparatus for sounding alarums at each end of the set, may also have duplicates of such dials, with needles and apparatus for alarums, at intermediate places, between the two ends; all such duplicates operating simultaneously with each other, and with the two end-dials and alarums, to give like signals, and to sound like alarums.

Sixthly, in the improvement, hereinbefore described and represented at fig. Y, sheet II, of the drawings hereunto annexed, for communicating determinate angular

motions to magnetic needles by subjecting them to the attractive force of occasional or temporary magnetism, which is excited in soft iron, by means of electric currents, for the purpose of giving signals in distant places by such determinate angular motions of needles.

Seventhly, in the improvement, hereinbefore described and represented at fig. R, sheet II, of the drawings hereunto annexed, for sounding alarums in distant places, either by direct application of the attractive force of occasional or temporary magnetism, which is excited in soft iron, by means of electric currents transmitted through metallic circuits, or else by applying the said attractive force of such occasional magnetism to let off ordinary clock-work alarums, and permit them to sound by the mechanical force and action of their own mechanism.

Eighthly, in the improvement, hereinbefore described and represented at fig. S, sheet II, of the drawings hereunto annexed, for sounding alarums in distant places, by the aid of an additional voltaic battery or alarum battery, which is brought into action when required for sounding the alarum; the sounding thereof being either by direct application of the attractive force of occasional magnetism, or by applying such force to let off clock-work alarums, as above seventhly stated; but according to this our eighth improvement, the requisite occasional magnetism is excited by an electric current derived from that additional battery; the metallic circuit by which that current is so derived from the said battery being formed (when the same is required to act) by an angular motion then communicated to a magnetic needle, which is disposed within multiplying coils of conducting wire, through which an electric current is transmitted from a distance; the said angular motion of the needle being caused to make the requisite contacts for forming the metallic circuit of the additional or alarum battery.

Ninthly, in the improvement, hereinbefore described and represented in fig. Q, sheet II, of the drawings here-

unto annexed, for effecting the contact requisite for forming a metallic circuit by which an additional or alarum battery is brought into action for the purpose of sounding alarums in distant places, as above eighthly set forth; but which contact, in this our ninth improvement, is effected by means of the evolution of gas arising from the decomposition of water which is included within a small close vessel, from which the gas cannot easily escape, wherefore it presses down the water, and thereby raises up a small column of mercury from the bottom of the vessel into the open leg of an inverted syphon tube, which is connected with the vessel, so as to raise the mercury up into contact with the end of a wire in order to form the required circuit.—In witness whereof, &c.

Enrolled December 12, 1837.

ORIGINAL PAPER.

An Examination of Walker's Patent Brewing Apparatus. By J. Wilson.

To the Editor of the Repertory of Patent Inventions.

Sir,—At the request of several gentlemen whose attention has been directed to Walker's Patent Brewing Apparatus (See page 44 of the present volume), I have investigated its operation; and I think it may interest your scientific readers if I give a detailed account of the examination I was enabled to make, and state its results. The apparatus appears to have been used more than six months in the brewery which I was requested to visit—[Our correspondent here describes the apparatus.] There were three distinct brewings (about 90 barrels) undergoing the process of cleansing, and each brewing was in a different stage, so that, in fact, I had the opportunity of observing the entire operation from the commencement to the termination. During the first stage of the process, the supply is conveyed into the barrel in nearly the same

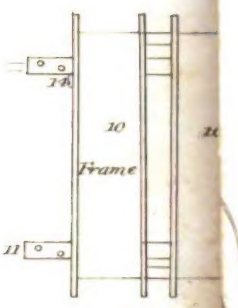
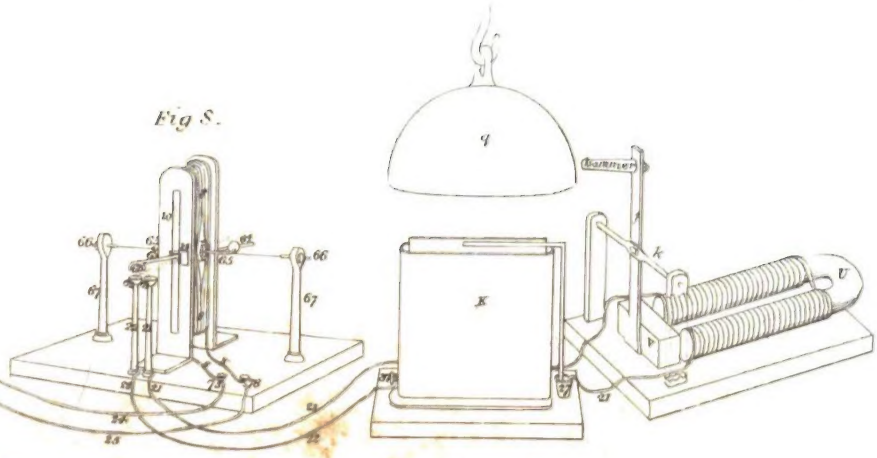


Fig D

Fig S.



Horizontal Pla

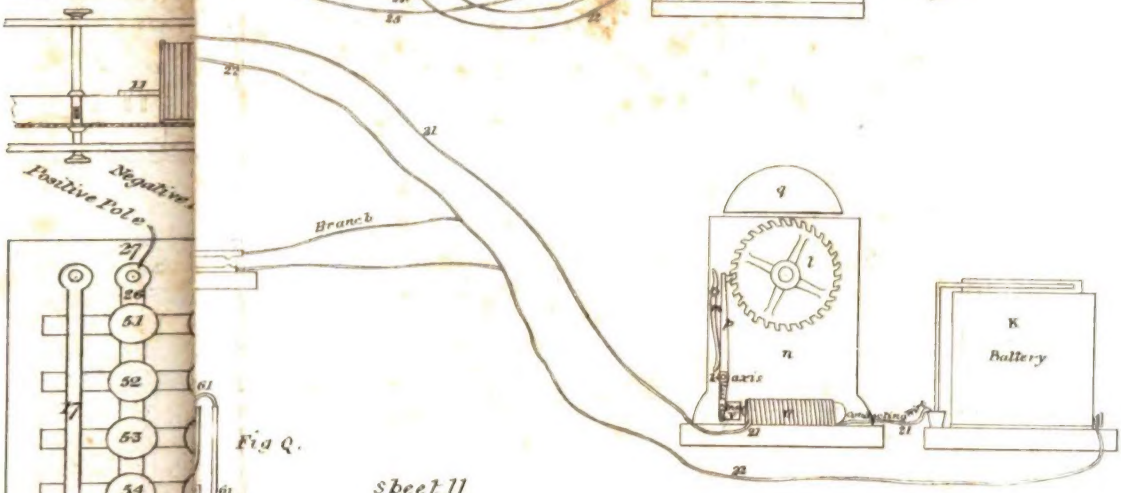


Fig Q.

Distant Terminus

Sheet II.

Fig W

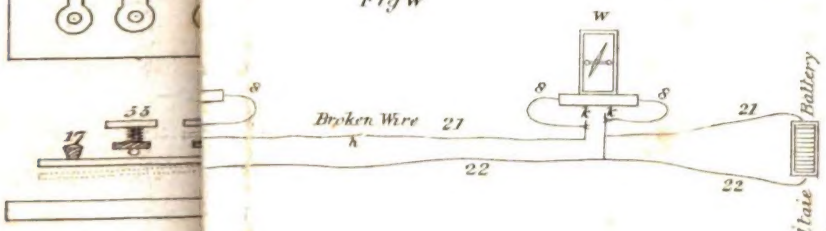


Fig Z.

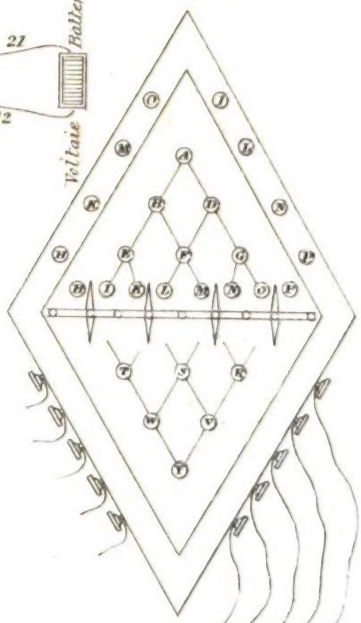


Fig L

Fig Y.

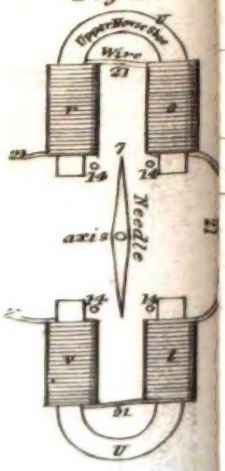
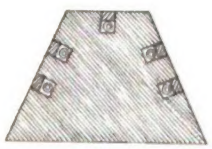
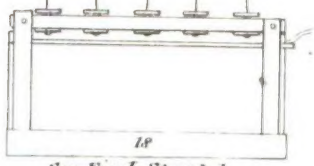


Fig 22.





See Fig I. Sheet I.